Forensic Science International 279 (2017) 122–129

Contents lists available at ScienceDirect

Forensic Science International

journal homepage: www.elsevier.com/locate/forsciint

Technical Note

An examination of the spatial distribution of the tissue fragments created during a single explosive attack

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ARTICLE INFO

Article history:
Received 6 December 2016
Received in revised form 9 August 2017
Accepted 14 August 2017
Available online 24 August 2017

Keywords:
Forensic science
Forensic archaeology
Explosives
Search and recovery

ABSTRACT

Throughout the course of a forensic investigation following an explosive attack, the identification and recovery of tissue fragments is of extreme importance. There are few universally accepted methods to achieve this end. This project aims to explore this issue through the examination of the spatial distribution of the tissue fragments resulting from an explosive event. To address this, a two stage pilot study was conducted: first, a series of controlled explosions on porcine carcases was undertaken. Second, the data produced from these explosions were used to chart the spatial distribution of the tissue debris. In the controlled explosions, 3 kg military grade explosive was chosen to create the maximum amount of fragmentation; this level of explosive also prevented the complete disappearance of forensic evidence through evaporation. Additionally, the blast created by military grade explosive is highly powerful and would mean that the maximum possible distance was achieved and would therefore allow the recorded distances and pattern spread to be a guideline for forensic recovery of associated with an explosive amount of an unknown size and quality. A total station was employed to record the location of the resulting forensic evidence, with the collected data analysed using R Studio. The observed patterns suggested that the distribution of remains is fairly consistent in trials under similar environmental conditions. This indicates potential for some general guidelines for forensic evidence collection (for example, the distance from the explosion that a search should cover).

1. Introduction

With acts of terrorisms on the rise, the ability to react and appropriately handle these situations effectively is of critical importance within the field of forensic science [1–4]. This includes the search and recovery of tissue fragments from victims on the scene at the time of the explosion. In the forensic literature, research on explosions has been primarily examined from two different perspectives: chemical and trauma analysis. Firstly, from a chemical analysis perspective the focus has been on the examination of the particles created by the explosive device to predict potential distance ranges expected from the explosive chemicals in a variety of situations [5,6]. Secondly, within the fields of forensic medicine and anthropology the focus instead has been on the types of trauma that occur to the victims of explosions: in particular, the emphasis with has been on the injuries obtained by members of the military serving in Iraq or Afghanistan [7–9]. However, while these two areas have been well addressed, there appears to be a lack of information regarding the pattern and spatial distribution of the tissue fragments that are created as a result of a (likely fatal) explosive event. This dearth is surprising considering how critical it is to know how far (and where) to search for potential fragments. The ability to quickly and efficiently search for evidence fragments is a requirements of any successful search and recovery operation.

The purpose of this current research is to address this gap in the literature with an aim to provide a more complete understanding of the spatial distribution of human tissue fragments specifically focusing on those produced by single-bomber (or suicide bomber) explosive events [10–12]. By having access to this data, experts will be able to conduct searches in a more efficient manner (quicker and more coherently), limiting unnecessary searches and reducing cost. Further, this will ensure that the critical forensic evidence can be collected in such a way that facilitates faster identification process of those tissue fragments.

In order to fully address this gap in the literature and produce concrete data which future forensic specialists can use and apply, it

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http://dx.doi.org/10.1016/j.forsciint.2017.08.017

is important to establish a universally applicable framework and set guidelines which recovery personnel can implement effectively. Following the National Academy of Science report (2009), the importance of developing a database that can be drawn upon in conducting forensic investigations and in the later evidence interpretation has become a main focus in the field of forensic science. This research aims to contribute to the slowly expanding forensic evidence base [13–15].

2. Methods and materials

2.1. Explosion parameters

In order to create an acceptable replication of a real world explosive attack event, this experiment needed to use an explosive material that would both create the necessary shockwave resulting in the fragmentation of the tissue and be a common explosive element used by terrorist groups [16–18]. From a fragmentation standpoint, the aim was to have sufficient separation of the material whilst not obliterating the forensic evidence entirely. In other words, the goal was to create small to medium sized fragmentation. Considering this, plastic explosive 4 or PE4, was chosen; this is a military high-brisance crystalline explosive known to be used in terrorist attacks, especially in the cases of state-sponsored terrorism where there is more access to military grade equipment [19,1,2]. The amount of explosive was based on a previous run of experiments and case studies that examined only the tissue injury and damage following a blast [20–22]. Pilot explosions were also performed in which the weight of the explosive was gradually increased until complete fragmentation of the target was obtained. The optimal amount was judged to be 3 kg of explosives, as this appeared to result in the desired complete fragmentation of the porcine test specimens; pigs (*Sus scrofa*) as commonly used as a human substitute in many fields, particularly within forensic science [23]. The deceased pigs used in the course of this experiment were purchased for 150 pounds per pig directly from a local farmer who raised them to sell as meat produce.

2.2. Experimental set-up

For these experiments, the explosive materials that comprised the bomb were placed together and wrapped with duct tape (Fig. 1). The finished bomb was then placed on the front and centre of the pig. This composition of the bomb was chosen for two reasons. The first was that by having the explosive material bound closely together, the resulting forces are produced in a central location that then spread outwards from the centre point. This was the easiest way to create the most powerful force that would produce the maximum tissue fragmentation. Secondly, it was also less expensive as it only used one primer charge to create the explosive train that produces the explosive force. The explosives were purposely not placed in any type of container or device, allowing for the examination of what happens to the tissue fragments with no other material involved.

The pigs were placed directly upright onto a wooden stake to resemble a suicide bomber (Fig. 2). As observed in Fig. 2, the position of the both the pig and the explosive of both the pig and the explosive was chosen as it allowed for the examination of the maximum distance obtained by the resulting tissue fragments as all of the force of the explosion was position in one direction against the pig tissue. The overall direction that the pig and the explosive faced varied due to the difficulty in getting the pigs

Fig. 1. A photograph demonstrating the composition of the explosive prior to detonation.

Fig. 2. A photograph representing the completed experiment set-up prior to detonation.